

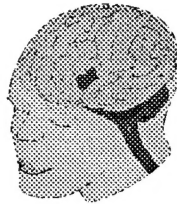


The British Psychological Society  
Cognitive Psychology Section



# Learning and the Human Brain

Cognitive  
Computational



Neuropsychological  
Neurophysiological

*Kings College, University of Aberdeen, Scotland, 26-28 July 1995,*

## Abstracts

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## ORAL PRESENTATIONS

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**Conceptual change in taxonomy revision: A simulation of psychological and historical data**  
*Alberdi, E. & Sleeman, D., Aberdeen, UK*

This paper describes psychological and computational research that we have conducted in a scientific domain: plant taxonomy. The purpose of the investigation was to explore the cognitive mechanisms involved in the theory revision tasks performed by expert scientists when they encounter novel unexpected data which contradicts their theoretical expectations. A psychological study of category induction was first conducted with the aim of investigating the procedures used by professional botanists as they tried to identify a botanical category from a set of positive and negative botanical instances. The link that defined the target category in the study was unusual and inconsistent with subjects' botanical knowledge; consequently, situations of uncertainty and puzzlement were generated. The results of the study indicated that, in order to cope with conflictive evidence, the botanists combined inductive search (based on observation and comparison of instances) with the application of background knowledge. These results were simulated in a computer programme which reproduced the categorisation behaviour of some of the subjects during the study. The mechanisms implemented in this programme were subsequently used in ReTAX, an artificial intelligence system for taxonomy revision. Additionally, using a set of consistency checking rules and a set of refinement operators, ReTAX succeeded to replicate some taxonomic revisions which have taken place historically in the botanical family Ericaceae.

**A standardised assessment of verbal and visuo-spatial memory in Epillepsy patients pre and post anterior temporal lobectomy.**  
*Andrewes, D., Dinjin, P., Layton, T. & Puce, A., Victoria, Australia.*

This paper presents evidence using pre and post surgery measures with temporal lobe epilepsy patients. 27 left and 25 patients with right seizure focus were compared on an automated verbal task and non-verbal visuo-spatial task. The tasks were matched for difficulty and mode of presentation. The standardised results showed a significant deterioration of verbal memory performance after left temporal lobectomy. The results are discussed in the light of a review of other studies which although using non-standardised tests have come to a similar conclusion. The implications for right hippocampal memory function are discussed in the light of apparently conflicting studies using stroke patients and the effects of seizures on memory.

**Using neuropsychological tests to examine a 'modular' model of cognitive change in healthy old age.**

*Askew, C., Rabbit, P., Manchester, UK.*

It has often been reported that most of the variance in the cognitive task performance of the elderly can be accounted for by a single performance parameter; (information processing speed or working memory capacity). Neuropsychological test batteries have been useful in the investigation of an alternative theory of cognitive ageing which is based on the premise that different cognitive functions are served by different parts of the brain and so may 'age' at different rates. Research from the fields of neuropsychology and biological and cognitive gerontology suggest that the frontal lobe may be particularly susceptible to normal ageing. This paper, then, addresses the use of some statistical techniques for examining proportions of age related variance in several batteries of "frontal" tests, and demonstrates that a single performance parameter cannot account for performance in all tests.

**Human Memory in Sickness and in Health (Public Lecture)**

*Professor A. D. Baddeley, FRS, Cambridge, UK*

Memory is one of the most crucial human capacities, and at the same time one of the most vulnerable to the effects of the disease. In recent years, our knowledge of memory has increased substantially, with many of the advances being attributable to the study of memory deficits following disease. A brief overview of current views on the structure of human memory will be presented, and then illustrated with examples from the way in which memory breaks down following disease or brain damage. Working memory is one component of memory that is specialised for holding and manipulating information as part of the processes of understanding, reasoning or learning. One part of this system uses subvocal speech to store verbal information, while another is concerned with imagery and temporary visual storage. In both cases we have learnt a great deal from patients who have suffered strokes. The capacity to co-ordinate these systems on the other hand has been studied principally in patients with Alzheimer's disease. Deficits in long-term memory are associated with many types of brain damage, ranging from the physical effects of a road traffic accident to some of the devastating impairments that can follow brain infection. A careful study of such memory problems not only helps us to understand the remarkable system that underlies our capacity to remember and learn, but also gives clues as to ways in which such patients may be helped.

**Amnesia and prose recall: Evidence for another component of working memory**

*Baddeley, A., Cambridge, UK.*

A study in which the Doors and People Test was used to assess visual and verbal recall and recognition in patients suffering from Alzheimer's disease suggested impaired learning but normal rates of forgetting. This contrasts with clear evidence of forgetting from immediate and delayed recall of prose and of lists of unrelated words. We argue that this discrepancy is attributable to the working memory component in the latter two tasks. Analysis of immediate and delayed prose recall in amnesic patients supported this view, provided one assumes that working memory is capable of temporarily sustaining representations in long-term memory, a view recently proposed by Ericsson and Kintsch.

**Declarative and procedural memory in routelearning in two subjects with longstanding topographic disorientation.**

*Barrow, C. & Williamson, J. Bolton, U.K.*

This paper presents the results of an investigation of declarative and procedural memory in routelearning in two subjects with longstanding topographic disorientation. Video presentation and actual navigation of a novel route were used in the present study to investigate declarative and procedural aspects of routelearning in these subjects. Assessment included route and landmark description, scene recognition (declarative knowledge), and accuracy of decisions made at choice points (procedural knowledge) which were dependent upon information relating to sequence, distance and direction of locations. This research was undertaken to investigate the nature of dissociable deficits affecting routelearning and to assess the effects of basic cognitive deficits on real-world topographic orientation.

### **Altered functional connectivity in memory processing in Alzheimer's disease**

*Becker, T., Mintun, A., Weisman, M.B., & DeKosky S.T., Pittsburgh, USA*

Studies of regional cerebral blood flow during the performance of cognitive tasks offers the opportunity to evaluate the patterns of functional connectivity among brain regions and among cognitive processes. In the present study, AD patients and normal control subjects performed one-, three- and eight-word recall tasks during  $^{15}\text{O}$ -water PET scans. Subsequent principal components analysis of the data revealed differences in functional connectivity between the patients and the controls: the principal difference being related to secondary memory processes. The AD patients, unlike the controls, have a functional system which includes bilateral parietal lobe (in the region of the supramarginal gyrus) as well as extensive areas of dorsolateral prefrontal cortex. These data indicate that AD patients have altered functional connectivity involving brain regions not normally associated with secondary memory, providing further evidence of the compensatory reallocation of cognitive resources which occurs early in AD.

### **Frequency and neighbourhood size effects in function of the processing level required by the lexical decision task: facilitatory or inhibitory?**

*Bozon F. & Carbonnel, S., Chambéry, France.*

The processing level required by the lexical decision task (LDT) for words differing on orthographic neighbourhood size and frequency, is studied by varying the discrimination degree between words and pseudowords. All the pseudowords presented have either many neighbours ("difficult" discrimination context) or no neighbours ("easy" context). Subsequently, the word processing level is also studied for the same words in a forced choice recognition task. The three distractors consist in their neighbours for the many neighbours words and in new words for the no neighbour words. A superiority of "easy" over "difficult" context is observed on the LDT results whereas the opposite is observed for the recognition task. An inhibitory neighbourhood size effect is observed in these two tasks. In the LDT, this effect which is only observed for low frequency words is marginally more important in the "difficult" context. These different discrimination contexts which seem to condition the subsequent recognition results, are interpreted as producing different encoding levels in the previous task.

**Towards a PDP model of how the brain processes sequential information**  
*Bradbury, D.C. & Le Voi, M., Milton Keynes, UK.*

An account of how the brain processes sequences is essential to a general model of human learning because many important psychological processes (for example speech recognition) are sequential in nature. One of the most useful methods of computational modelling is the use of Parallel Distributed Processing (PDP) techniques. There exists a specialised class of PDP models, known as recurrent networks, which are able to handle such sequential problems. A comparative study of the ability of recurrent networks to process sequences is a way to choose one type of model over another and the results of such a comparative study are shown. Some aspects of the physiology of sequence processing are discussed, together with a look at how this knowledge can be applied to recurrent networks in order to provide a PDP model of sequential processing in the brain. The results indicate that a gamma model of short-term memory is both neurologically plausible and computationally effective.

**Face Recognition and learning: Towards a unified theory**  
*Mike Burton, University of Glasgow*

Research in the cognitive psychology of face recognition has tended to emphasise memorial processes, and to ignore 'front-end' perceptual processes. However, recent developments in the field have forced researchers to address the whole sequence: from raw visual information to retrieval of facts about people. In this talk I will describe a model of the whole process. Analysis of images is performed using principal components techniques, and the results of these analyses are used to access the memory system. The model can easily be represented as a connectionist simulation.

I will present some data on learning new faces. Patterns of success and failure of human subjects appear to be captured by aspects of this model. Furthermore, some patterns of familiar face recognition appear to be easily accounted for. Finally, I will argue that learning and steady-state models of face recognition must be integrated if we are to understand either process adequately.



### **Long-term recognition of unrelated words with amphetamine**

*Casaer, S. & Soetens, E.* Brussels, Belgium.

Previous experiments with free-recall tests have shown that amphetamine enhances human memory consolidation. These experiments have been criticised because of repeated testing of the same material. This influence was eliminated using recognition tests of parts of the target list on different delays of 10 min, 1 day and 1 week. Whereas in recall experiments we found an amphetamine improvement after one hour, with recognition significance was only reached after one week. Because recognition is easier than recall, a ceiling effect in the placebo condition could be the cause for this difference. In a second study, subjects supplementary had to decide if a recognised word belonged to a first or a second target list. No amphetamine improvement was found in recognition, but there was a significant amphetamine improvement for determining the allocation of the words on all tests. Amphetamine enhancement also applies to recognition of unrelated words, but it only shows in tasks with enough memory decay.

### **The influence of semantic encoding on recognition memory in Alzheimer's disease**

*Dalla Barba, G. & Goldblum, M.C.,* Paris, France.

Within the framework of the classical distinction between episodic memory and semantic memory (Tulving, 1972, 1983), it has been argued that these two memory systems are organised in a hierarchical way (Tulving, 1983, 1984). The hierarchical hypothesis assumes that episodic memory is a specific subsystem of semantic memory and therefore implies that episodic memory can not exist without semantic memory. Although this hypothesis has not gone unchallenged, only few experimental studies have focused on this topic. If this hypothesis is correct, it should be expected that (episodic) Yes/No recognition performance would improve in patients with preserved semantic memory, following semantic encoding. On the contrary in patients with impaired semantic memory, performance on recognition memory shouldn't be affected by encoding conditions. Poor performance in tasks tapping episodic memory is an almost constant symptom in patients with Alzheimer's disease (AD), whereas semantic memory problems are usually more prominent in later stages of the disease. We studied the influence of semantic encoding on recognition memory performance. The aim was to investigate whether, holding constant the material variable, subjects' performance on a semantic association task would be correlated with the performance on a recognition memory task. 17 AD patients together with 17 normal controls entered the study. Experiment 1. 12 cards, each representing three different pictures (a target picture a picture semantically related to the target and a distractor) were presented one after the other. After the presentation subjects were given a recognition test consisting of the 12 studied items together with 12 lure items. Experiment 2. 12 cards were presented and subjects were instructed to chose the picture they considered more related to the target. Following the presentation subjects were given a recognition test consisting of the 12 studied items together with 12 lure items. A significant correlation ( $p < 0.05$ ) was found between AD patients' performance at the semantic association task and their performance at the recognition task of Experiment 2. By contrast, there was no correlation between patients' performance at the semantic association task and their recognition performance in Experiment 1. The findings of this study show that the ability to make a semantic association between two items is correlated to the ability to recognise, in a subsequent test, those same items and give further support to the view of episodic memory as strongly dependent upon semantic memory.

## **Exploring disorders of semantic memory**

*John R. Hodges, Cambridge, UK.*

This paper will concentrate on the study of patients with progressive, yet relatively pure, semantic memory breakdown, a syndrome recently accorded the label of 'semantic dementia', but will also draw on data from patients with dementia of the Alzheimer's type (DAT) in whom loss of semantic memory is almost invariably accompanied by impairment in episodic memory.

Our research has focused on the following: (1) the longitudinal study of patients with semantic dementia has confirmed the preservation of broad superordinate information with loss of finer grained or subordinate knowledge. Although this pattern of results is traditionally interpreted as supporting a hierarchical organisation, we favour a distributed feature network view. By this account, a degraded semantic network is better able to support general as opposed to specific distinctions. A related issue which we have addressed is the question of whether naming depends upon access to a specific subset of perceptually-based semantic knowledge which is relatively separate from other associative information. (2) The second major area of interest concern the interaction of semantic memory with other cognitive 'modules'. It appears that some are dependent upon the integrity of semantic memory (e.g. phonological word representations, structural descriptions of objects etc) while others are relatively independent (e.g. working memory, non-verbal problem solving, high level perceptual and syntactic abilities etc.). (3) A third topic of study is the relationship between semantic and episodic memory. We have shown that patients with semantic dementia perform normally on some traditional tests of episodic memory and show a reverse temporal gradient on tests of autobiographical memory, a finding which is interpreted in the context of contemporary models of hippocampal-neocortical memory systems. (4) We have also investigated the neural basis of semantic memory by the use of high resolution 3-D MRI imaging. These studies point to the critical role of the left infero-lateral temporal neocortex for general semantic knowledge. Parallel right-sided structures may have a role in some aspects of non-verbal and person-based semantic knowledge.

## **Serial reaction time learning and Parkinson's disease: Evidence for a procedural learning deficit.**

*Jackson, G.M., Jackson, R., Harrison, J., Henderson, L. & Kennard, C., Bangor & London, UK.*

This paper presents evidence in support of a serial reaction time (SRT) deficit associated with Parkinson's disease, and related to the acquisition or execution of serial-order information. Eleven patients with idiopathic Parkinson's disease, and ten age-matched but otherwise healthy control subjects, were compared on a variant of the SRT task introduced by Nissen and Bullemer (1987). The results of this study clearly demonstrate that PD patients produce a quite different pattern of RT performance to that of control subjects. Such a pattern of results may reflect either: 1. a deficit in the patients' ability to learn the temporal order information provided by a repeating sequence of target locations in the SRT task; or 2. a deficit in the patients' ability to express temporal order information provided by the repeating sequence of target locations in the SRT task.

### **How will route guidance systems affect our memory for routes?**

*Jackson, P.G.*, London, UK.

At the heart of all spatial behaviour, for example, wayfinding and navigation, lies our ability to acquire and manipulate mental representations of our spatial surroundings, the process known as 'cognitive mapping'. This process is receiving renewed attention because of the planned introduction of route guidance and information systems into vehicles, and concern about the effects that these systems will have upon driver behaviour. These systems are predicted to offer benefits both to the individual user and to the transport system as a whole, predicted to offer benefits both to the individual user and to the transport system as a whole, by expanding individuals' cognitive maps of an area, thus providing a greater range of choices from which to select a suitable course of action. However, little is known about the effects of additional information upon the cognitive mapping process: will it help or hinder the acquisition and use of cognitive maps? This paper presents a new methodology which uses video footage to provide a standardised experimental environment suitable for researching the knowledge acquisition process. In addition, one group will see the films while hearing route guidance instructions as a means of investigating the effect of receiving such information upon the cognitive mapping process.

### **Diencephalic, temporal and frontal amnesia - Do they really differ?**

*Kopelman, M.*, London, UK.

Many claims have been made about differences in the pattern of memory deficit following lesions in the diencephalon, temporal lobes and frontal lobes. For example, claims have been made about differences in rates of forgetting, the patterns of retrograde amnesia, the effects upon memory for context and upon the organisation of memory and retrieval processes. However, the location of the lesions in many of these studies has been based purely upon clinical assumptions, and not by concurrent neuroradiological investigations. Moreover, neuro-imaging studies suggest that the metabolic effects of any given lesion may be much more widespread in the brain than is evident from the location of damaged structure revealed on neuroradiological scans. The present study will report findings with respect to these memory processes in patients who have had both MRI and PET investigations, and the results will be related to the sites of underlying lesion.

### **Reinforcement without awareness: A new paradigm and some data**

*Lieberman, D., Stirling, UK*

One problem in past experiments attempting to demonstrate reinforcement without awareness has been that the reinforcement contingency was relatively obvious, so that subjects readily became aware of it. To minimise awareness, we used an ESP cover story in which subjects were asked to say which of two words the experimenter was thinking of, and then told whether their response was correct; in fact, reinforcement depended on either the loudness of their response or on whether they chose the word in each pair which contained a double letter. The reinforced response increased substantially over trials, but extensive questioning suggested that subjects were not aware of the actual reinforcement contingency or of one correlated with it.

### **Spatial mapping and the hippocampal formation in humans**

*Morris, R.G., London, UK.*

O'Keefe and Nadel's (1978; 1991) have proposed that the hippocampal formation is concerned with the representation of allocentric (or view dependent, spatial information in the form of a map. This theory, applied to rodents, suggests that the hippocampus builds up a map for each environment that is experienced. O'Keefe and Nadel (1991) have extended this theory to humans with the notion that only the right hippocampus is specifically concerned with spatial mapping. The paper overviews the results of a series of studies by Morris and co-workers to test this theory in patients with unilateral lesions of the hippocampal formation. The first study investigates spatial memory in patients with temporal lobe epilepsy who have focal lesions identified using magnetic resonance imaging within either the left or right hippocampal formation, comparing their performance with those who have undergone left or right temporal lobectomy. The right lesioned patients were found to be selectively impaired on the spatial component a human analogue of the Olton Maze task, but not specifically on a working memory component or object recognition. A further study, using a series of computerised tasks incorporating computer graphics to simulate three-dimensional space also showed selective deficits in spatial memory functioning. Together these studies support the right hippocampal formations involvement in spatial mapping in humans.

**Memory and consciousness: A component process view with evidence from normal and brain-damaged people**

*Moscovitch, M.*, Toronto, Canada

Behavioural and neuroimaging studies on people with normal or impaired memory will be presented in support of a component process model of memory. In particular, the studies will provide information about the contribution of medial-temporal, prefrontal and posterior neocortical structures to performance on explicit and implicit tests of memory for words, objects, and spatial location. If time permits, data on the effects of psychosocial factors on memory and cognition in the elderly will also be presented.

**Computational modelling of the development of representation in the mammalian cerebral cortex**

*Oliver, A., Shrager, J., Johnson, M.H.*, London, UK

This paper describes how connectionist modelling techniques may be used to examine the relationship between endogenous, exogenous and dynamic factors in the development of representations in the mammalian cerebral cortex. It is proposed that representations develop through the interaction of these factors by a combination of co-operative-competitive, progressive-regressive and dynamic processes. A series of simulations conducted with a simple cortical matrix model will be presented. These simulations illustrate the importance of the correlational structure of the input, the interconnectivity of the network, and the temporal dynamics of putative 'growth factors' on the spatial location and type of functional representations that emerge in the network. Some applications of the results of these initial simulations to real examples, such as the development of intermodal representations will be discussed.

### **A neural network modelling the light-adaptive properties of the natural retina**

*Piccinini, F., Ratto, G.M. & Starita, A., Pisa, Italy*

Nowadays there's a growing interest into the possibilities offered by the connectionist model to study biological mechanisms and behaviours. In this paper we shall propose a connectionist approach to model the light-adaptive properties of the retina.

### **Confidence and consciousness in recognition memory**

*Postma, A., Utrecht, The Netherlands*

One may recognise an item with or without any conscious recollection of its prior occurrence. These, so called, 'remember' and 'know' responses might be measures of distinct memory systems. Alternatively, they could simply correspond to 'strong' and 'weak' memory traces. To further explore this latter possibility, two groups of subjects performed the same recognition task under different retrieval instructions. One group was told to be very sure of each item they selected, whereas the other group was instructed to just pick any item they thought they recognised. The latter group had about as many 'know' responses as the former, but substantially more 'remember' responses. This seems to confirm the idea that 'remember' and 'know' responses reflect different memory systems. However, the fact that confidence ratings were higher with 'remember' responses appears more in line with the trace strength alternative.

### **Sub-clinical effects of mild head injury on attention and memory**

*Potter, D.D., Keele, UK*

Mild head injury can have a variety of outcomes. In the majority of cases most symptoms resolve in days or weeks. In the present study young healthy volunteers who had sustained a mild head injury in the last 2 years were compared to individuals with no history of head injury on the following tasks: 1) The Paced Auditory Serial Addition Task (PASAT) with concurrent ERP recording. 2) An auditory 'oddball' or vigilance task designed to evoke a P3a ERP. 3) A small battery of neuropsychological tests which have previously been shown to identify memory and attention impairments after closed head injury. Preliminary results show that, while these subjects do not complain of persistent symptoms, they show evidence of mild memory impairment on a paired associate task. While all other behavioural measures show little sign of impairment, the ERPs in both the PASAT and 'oddball' tasks show a pattern of results which is consistent with abnormal attentional function. These results will be discussed within the context of the role of frontal lobe structures in working memory function.

### **Memory impairment in multiple sclerosis: Reports of patients and relatives**

*Richardson, J.T.E., London, UK*

This paper reports the results of a questionnaire survey on problems in everyday memory that involved 115 community-based patients with multiple sclerosis (MS) and their carers or close relatives. Cluster analyses of their responses enabled the patients to be classified as either 'impaired' or 'unimpaired', though the salient items differed between the reports of the patients and the relatives. Both the self-reports and the relatives' reports indicated that roughly 10 per cent of the patients were impaired, a much lower estimate than that which was previously suggested based upon psychometric testing. It is concluded that neuropsychological assessment may underestimate the capacity of MS patients in their daily activities.

### **What the brain needs to learn**

*Richardson, K., Milton Keynes, UK.*

The argument of this paper is that the special task of higher cerebral processes, and the basis of their evolution, is the maintenance of predictability in highly changeable (especially social) circumstances. This is done, we maintain, through the capture of the mutual information (covariation) structure of experience, and its internal representation in the form of nested covariation hyperstructures. This theoretical idea was tested using highly-degenerate point-light stimuli which varied in both the amount and structure of the covariation they contained. Various response parameters were associated with both the overall covariation content of the stimuli and the 'structuredness' of that information. The theory and results have a number of implications for the understanding of cerebral/cognitive architecture and its role in learning and cognition.

### **Neural modelling of the human control system: an interdisciplinary study**

*Ronco, E. & Gawthrop, P., Glasgow, UK*

The main aim of this study is to show how to increase the practical utility of neural networks for control engineering while making this neural model more realistic according to the natural learning systems. The passivity of neural networks could be a reason why they have a very limited learning ability compared to the biological systems that continually manage the flow of information that comes from the environment and then perform a "progressive complexity learning". After a life science study, we argue that in an internal point of view, this progressive learning could be described as a progressive and hierarchical modularity of the learning control system. Then, we show the interests for control engineering and life sciences of such a modular neural control scheme. We end this paper by discussing the main problem that remain to solve to implement this model: how to split up the environment systematically in a "relevant manner".



### **Phonological memory in learning active and passive vocabulary**

*Service, E., Gathercole, S., Hitch, G. & Martin, A., Helsinki, Finland; Bristol & Lancaster, UK.*

When vocabulary is learned the "passive route", a new meaning is connected to a label so that whenever the label is encountered it brings to mind the meaning. Learning the "active route" means that a label becomes available for production whenever the corresponding meaning is activated. Previous studies have shown a relationship between phonological working memory and vocabulary learning. According to Ellis and Beaton (1993) phonological memory is needed for the active route. We explored a range of learning tasks: *paired-associate learning* with *word-word* or *word-pseudoword* pairs and learning *pseudoword forms* or *definitions in a story context*. We also measured native-language and foreign-language vocabulary in our subjects. Learning of definitions was not related to phonological memory. In contrast, learning words the active route was related to both phonological memory and episodic memory for associations between meaningful words. Acquisition of new vocabulary was consistently related to all the laboratory learning tasks except the word-word task. The results support claims for specific links between phonological working memory and the storage and retrieval of phonological specifications of new words.

### **Glia and brain mechanisms underlying learning**

*Wallace, J.G. & Bluff, K., Victoria, Australia.*

Neuropsychological accounts of learning frequently rely heavily on the occurrence of synaptic facilitation due to long term potentiation (LTP) produced by Hebbian learning as a result of a conjunction of presynaptic and postsynaptic activity. Recent results of neurophysiological and neurochemical experimental studies, dealing both with timing and outcome data, are very difficult to reconcile with current accounts of LTP mechanisms. A modified paradigm can be derived by extending consideration to glial cells and, in particular, astrocytes. Astrocytes appear to possess a type of intracellular calcium dynamics which provides a basis of excitability for signalling between them. This raises the possibility that astrocytic networks engage in information processing with very different temporal and spatial characteristics from neuronal signalling. Drawing on a wide range of glial experimental evidence a learning mechanism is described enabling astrocytes to interact with neurons in a fashion which greatly enhances the effectiveness of long term synaptic facilitation. The general and specific performance characteristics of this mechanism are being explored by means of a computer model.

**Theory of human learning**  
*Wetherick, N., Edinburgh, UK.*

It is argued that, since brain mechanisms account for human learning, any theory of learning must have an evolutionary base, showing how human learning capacity evolved. Each organism faces a different challenge from its environment, so capacity to learn must have played a significant role in determining individual survival changes at every evolutionary level. Much information is now available about the learning capacities of organisms at different levels, on which to base such a theory. Everywhere the problem is to predict what will happen next and what may best be done about it, using as much of the predictive information potentially available in the environment as the organism's level of learning capacity permits. Major technical advances were achieved at the mammalian level (use of negative information as well as positive) and at the human level (use of recall of past experience as well as present experience, allowing quantification over events).

## **POSTER PRESENTATIONS**

### **Processing efficiency and short-term memory span in mental addition**

*Adams, J.W., Lancaster UK*

Two experiments investigated the relationship between arithmetical processing speed and the capacity to perform mental arithmetic, as assessed by a novel 'mental addition span task'. Addition span was measured across age, along with a manipulation of the difficulty of operations. Strong effects of age and problem difficulty on subject performance were found across both experiments. Results of both experiments showed a significant linear correlation between speed and span across changes in both problem difficulty and age, a result consistent with the theory outlined by Case et al (1982). Experiment 1 used verbal measures of speed and span. Experiment 2 used both verbal and visual measures, the verbal data being similar to that previously obtained. However subject performance on the visual tasks was found to be significantly better. The presence of a sum throughout the solution process was found to be of clear benefit. This supports the view that working memory plays a crucial role in limiting a subject's ability to perform mental arithmetic of increasing complexity.

### **The everyday functioning questionnaire: An assessment of a new measure designed for the measurement of everyday functioning in neurosurgical outpatients.**

*Andrewes, D.G., & Hordern, C. Victoria, Australia*

40 neurosurgical patients and their partners reported on the patients' everyday cognitive and emotional problems following brain-surgery using especially designed versions of the everyday functioning questionnaire (EFQ). These results were compared with a control group of 23 patients who had undergone surgery to extra-cerebral areas. The EFQ and three of its five subscales were found to discriminate between the two groups and factor analysis revealed a sound construct validity. The relationship between the EFQ and the neuropsychological test results on a sub-sample of patients found the partner's EFQ to have greater concurrent validity when compared to the patients self-report. The application of the EFQ assessment prior rehabilitation is discussed.

**The application of ERP techniques to the study of implicit and explicit memory in amnesia patients**

*Barrow, C., Sharpe, H., & Mayes, A., Bolton & Sheffield, UK*

The enormous task of understanding why the physicochemical processes of the brain give rise to the mind will be facilitated by a multidisciplinary approach between the brain sciences and the behavioral sciences (Kutas and Hillyard, 1984). With this aim in mind there has been an increase in the use of event-related potentials (ERP's) in psychology to measure the order and timing of cognitive processes. Research at Bolton aims to explore the dissociation between implicit and explicit memory using the ERP paradigm with amnesic patients (as compared to controls) since a great deal of evidence exists which indicates that amnesic implicit memory remains intact whereas explicit memory does not (Shimamura, 1986). Implicit memory tasks involving priming and explicit memory tasks were constructed according to whether previous studies had indicated their feasibility for ERP research. Preliminary data will be presented for amnesics and controls.

**Multiple components of the perception and imagery of musical sequences: a cognitive neuroscience analysis and some implications for auditory imagery.**

*Carroll-Phelan, B. & Hampson, P.J., Cork, Ireland*

In this article a cognitive neuroscience perspective is applied to auditory perception and implications derived for imagery. A computational analysis, of the major functions required of auditory perception of musical sequences is first carried out, and a neurologically plausible model of music processing constructed. Aspects of auditory imagery, thus far uncovered by existing research programmes, are revealed, namely its incorporation of rhythmic as well as pitch components, a long term memory for melodic strings and its relationship with associative memory. The present account builds on a recent model of music perception proposed by (Peretz, 1993), and also accounts for data from studies of patients with disorders of rhythmic processing, indicating the close relationship between auditory imagery for rhythmic sequences and motor processes. The model is then applied to the perception, recognition and recall of musical sequences. Recent data bearing on major aspects of the model are used to refine and extend the minimal model and provide a framework for research programmes in this area. Issues for future empirical work are also discussed and several working hypotheses on the nature of auditory imagery outlined.

### **Absence of recency effect in a patient with normal short-term memory.**

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In this paper we describe a patient with a left parietal lesion following a severe head trauma who presented an unusual pattern of memory performance: he was normal in span tasks and defective in long-term learning, but, in contrast with what is predicted by the current models of memory and learning, he showed the primacy but not the recency effect in immediate verbal free recall. When asked to recall the final items of the list first, the pattern reversed and only primacy was evident. This finding seems to suggest that the recency effect can arise from a range of memory systems and reflects the activity of any memory system that is subject to gradual loss of information over time and requires a retrieval strategy.

### **Working memory deficits in Parkinson's disease: the effect of withdrawal of dopaminergic medication.**

*Fournet, N., Roulin, J.L., Moreaud, O. & Pellat, J., Chambéry, France*

A frontal dysfunction has been frequently described in Parkinson's disease (PD), explained by an attentional deficit in the central executive component of Baddeley's Working Memory (WM) model. The neurophysiological basis of this cognitive dysfunction remains unclear: the dopaminergic pathways linking striatum and frontal cortex, disturbed in PD could be involved. In order to explore the hypothesis of a central executive deficit in PD, 12 treated PD patients and matched controls were given verbal, spatial and double span tasks (assessing each component of the WM model).

In order to specify the links between WM deficits in PD and dopaminergic deficiency, 12 other PD patients were studied On and Off dopaminergic medication, using the same span tasks. We observed:

- 1) a global and unspecific decrease of performances in PD patients compared with controls.
- 2) deficits of PD patients Off medication only in the double span task evaluating the central executive. These results seem to indicate an effect of dopamine which would specifically affect the central executive. In order to corroborate these results, a control experiment using a dual task paradigm is currently designed to assess the 'time sharing' function of the central executive.

**Category-specific impairments of semantic memory associated accompanied by loss of memory for people due to predominantly temporal lobe damage.**

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This paper details 3 cases (right-handers) of semantic amnesia which exhibited different types of category-specificity and contrasting distribution of cerebral involvement. The first 2 cases with predominantly left temporal lobe atrophy and hypometabolism (PET) presented transcortical sensory aphasia, exhibiting later marked impairment of semantic memory for common objects in daily use and mental deterioration in the absence of semantic amnesia for persons and animate objects. In the 3rd case with predominantly right temporal lobe atrophy and hypometabolism (PET), marked impairment of semantic memory for familiar persons as well as animate objects (animals, vegetables) was confirmed in the absence of mental deterioration in the initial stage, developing in the course of 3 years more extensive impairments of semantic memory (for monumental buildings, professional clothings, social signs, common objects). All 3 cases exhibited no explicit deficits in episodic memory and visuo-spatial abilities.

**The relationship between psychometric intelligence and performance on two dynamic systems tasks.**

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Results are reported from a correlational and factor analytic analysis of the relationships between performance on two dynamic systems tasks and standard measures of psychometric intelligence. Previously it has been argued that explicit and implicit learning can be dissociated on the basis of their relationships with traditional measures of psychometric intelligence. A dynamic systems task thought to favour an explicit learning mode was found to correlate with WAIS-R derived intelligence measures whilst the task thought to favour an implicit learning mode did not. Analysis of the relationship between the dynamic systems tasks and the two main factor solutions suggested for the WAIS-R also supported this dissociation. These results are discussed in relation to previous analyses of the relationships between explicit tasks, implicit tasks and psychometric intelligence.

### **Learning of individuals with brain injury - Methodology approach.**

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Brain injuries usually cause two types of functional deficits: of cognitive (attention, memory, thinking) and of motor (ideator and ideomotor movements, sequential and nonsequential movements) functions.

Consequently, coping with learning disabilities becomes one of the main problems in the process of rehabilitation. Therefore, a number of questions related to the methodology of re-education and regaining lost functions need to be answered to.

The question that arises now is HOW to organise the re-education. Which type should be given the priority: the cognitive or the motor re-education? Should all deficits of the cognitive and motor functions be treated simultaneously or separately? The questions that follow are the ones related to the strategy, tactics and the conditions of re-education.

### **Bidirectionality of interference in Stroop-type tasks.**

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Papua New Guinean multilingual subjects proficient in English participated in two experiments, one a traditional Stroop colour-word interference task and the other, a picture-word version of the same task. All naming was required in English. Interference was obtained from words in naming both colours and pictures, as expected. However, interference in the opposite direction (reversed interference) was also obtained, such that colours and pictures significantly slowed word naming. Naming speeds of words, colours and pictures presented alone were close to those of a group of monolingual English speakers and are consistent with those reported by previous researchers using monolingual subjects. Later experiments indicated that bidirectional interference was not associated with greater attention being paid to the 'irrelevant' stimulus component. Bidirectional interference was strongly correlated with English acquisition age though this effect was not directly related to proficiency. Explanations of the Stroop and related effects that focus on the asymmetry of the interference obtained are, necessarily, inadequate to deal with the relatively symmetrical interference obtained in such multilingual subjects.



### **Contextual recollection impairment in frontal lobe patients.**

*Van der Linden, M., Meuleman, T. & Rolland, J., Liege & Tours, Belgium*

The aim of the present study was to investigate the performance of patients, with lesions circumscribed to the frontal lobes, on two recognition tasks: a synonym distractor task in which contextual recollection was likely to play a significant role and a modality recognition task deigned to explore memory for contextual information (modality of presentation). Nine control subjects and 9 patients with circumscribed frontal lesions were examined. The results confirm that frontal patients are impaired on recognition tasks which contain a recollective element. However, they also suggest that frontal patients showed normal ability to encode some noncontent attributes, particularly modality of presentation.

### **Performance of multilinguals in language-based tasks: The effects of acquisition age and hemispheric laterality for language.**

*Wuillemin, D., Victoria, Australia*

Papua New Guinean multilingual subjects were tested for hemispheric laterality for naming English and Tok Pisin words using a divided visual field technique. Age of acquisition of the test language proved to be a significant contributor to the laterality effects obtained; older acquirers (8-12 years) of both English and Tok Pisin showed greater right hemisphere involvement than early acquirers (0-4 years). Hemispheric laterality for English did not prove to be related to other language performance measures including proficiency, short-term and iconic memory test scores, and picture-word Stroop-type interference task performance. However, acquisition age of English was correlated with performance on all of these tasks and with overall reaction time and accuracy of responses. The strong influence of acquisition age on cerebral laterality for language and the even stronger influence on performance in language-based tasks is interpreted as supporting the existence of a critical period for language learning.